



Surface BRDF/Spectral Albedo Retrieval: NPOESS VIIRS Algorithm

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Abstract

VIIRS/NPOESS algorithms and procedure for spectral albedo computation, along with preliminary experimental results are presented. The primary difference between this algorithm and the MODIS BRDF algorithm is its use of the best BRDF model out of twelve linear kernel model combinations, and three criteria options. The model parameter retrieval is an inversion problem that is solved using singular value decomposition (SVD) numerical routines. The SVD routines also make the analysis of model parameter variance and white-sky variance straightforward. Primary field data tests and simulation studies indicate that the algorithm is accurate and reliable.

Introduction

The VIIRS surface albedo algorithm consists of three components: the computation of surface bi-directional reflectance distribution function (BRDF), the computation of black- and white-sky albedo and interpolation of the spectral albedo, and the computation of broadband albedo. This work aims to describe the first two components in detail, particularly the inversion process that calculates the surface BRDF and the spectral albedo computation.

VIIRS/MODIS Bands

VIIRS		MODIS	
Band	Spectral Range	Band	Spectral Range
M1	0.402-0.422	8	0.405-0.420
M2	0.435-0.455	9	0.438-0.448
M3	0.478-0.498	10	0.483-0.493
M4	0.545-0.565	4	0.545-0.565
M5	0.662-0.682	1	0.620-0.670
M7	0.846-0.885	2	0.841-0.876
M8	1.230-1.250	5	1.230-1250
M10	1.580-1.640	6	1.628-1.652
M11	2.225-2.275	7	2.105-2.155

VIIRS Algorithm Description

Kernel Model

$$\rho(\theta, \vartheta, \phi, \Lambda) = f_{iso}(\Lambda) + f_{vol}(\Lambda)K_{vol}(\theta, \vartheta, \phi) + f_{geo}(\Lambda)K_{geo}(\theta, \vartheta, \phi)$$

Black-sky Albedo

$$h_k(\theta) = \frac{1}{\pi} \int_{\phi=0}^{2\pi} \int_{\vartheta=0}^{\pi/2} K_k(\theta, \vartheta, \phi) \sin(\vartheta) \cos(\vartheta) d\vartheta d\phi$$

White-sky Albedo

$$H_k = \int_{\theta=0}^{\pi/2} h_k(\theta) \sin(\theta) \cos(\theta) d\theta$$

Kernel Combinations

number	Kernel model
1	Ross-thick and non-reciprocal Li-Sparse
2	Ross-thin and non-reciprocal Li-Sparse
3	Ross-thick and reciprocal Li-Sparse
4	Ross-thin and reciprocal Li-Sparse
5	Ross-thick and non-reciprocal Li-Dense
6	Ross-thin and non-reciprocal Li-Dense
7	Ross-thick and reciprocal Li-Dense
8	Ross-thin and reciprocal Li-Dense
9	Ross-thick and LiTransit
10	Ross-thin and LiTransit
11	Ross-thick and Roujean
12	Ross-thin and Roujean

BRDF INVERSION PROCESS

INVERSION METHOD: Singular Value Decomposition

MODEL SELECTION CRITERIA:

1. Root Mean Square Error

$$\delta = \sqrt{\frac{1}{N_b} \sum_{ch} RMSE_{ch}^2}$$

2. Coefficients Variance

$$\sigma^2 = \sum_j \sigma^2(f_j)$$

3. White-sky Albedo Variance

$$\sigma_{a_{ws}}^2 = H \cdot F_{cov} \cdot H^T$$

Magnitude Inversion Process

$$\rho_l^{his} = \sum_i f_i^{his} K_i(\theta_l, \mathcal{G}_l, \phi_l)$$

$$sum_2 = \sum_{l=1}^m \rho_l^{his} \cdot \rho_l^{his} \cdot w_l$$

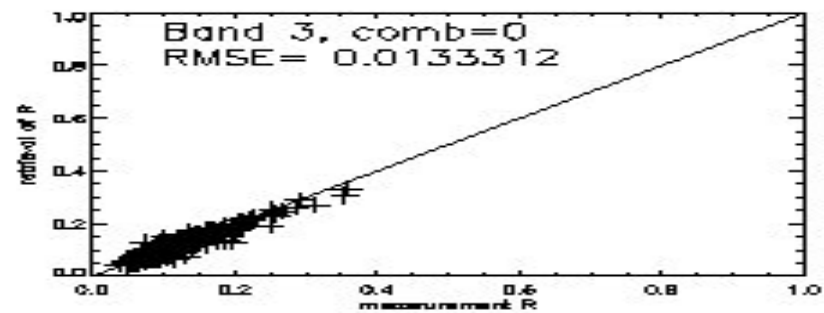
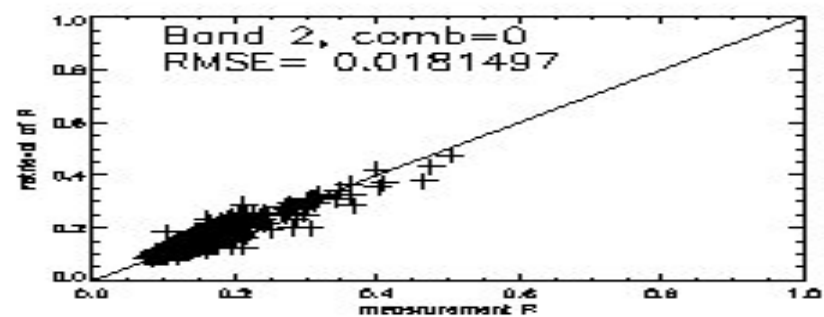
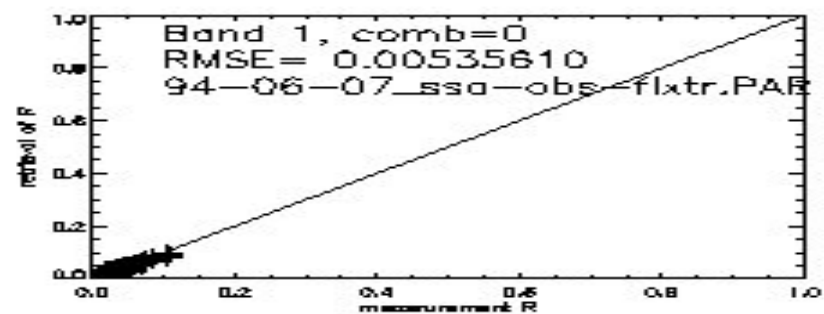
$$sum_1 = \sum_{l=1}^m \rho_l^{obs} \cdot \rho_l^{his} \cdot w_l$$

$$f_i^{new} = \frac{sum_1}{sum_2} \cdot f_i^{his}$$

FIELD DATA EXPERIMENT

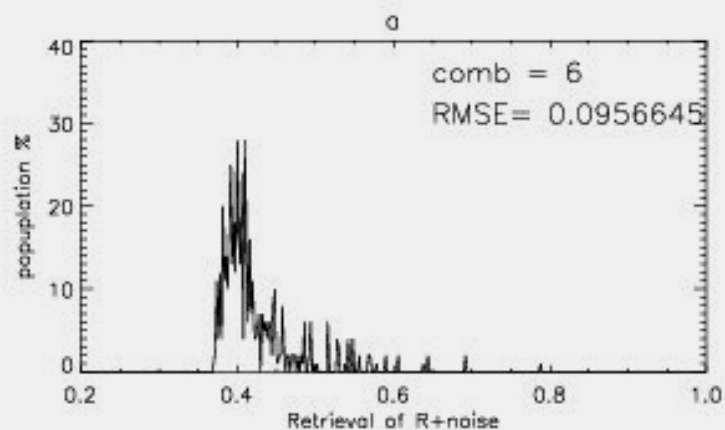
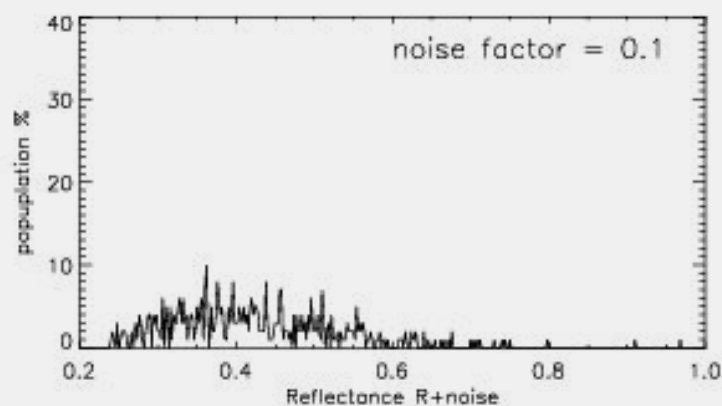
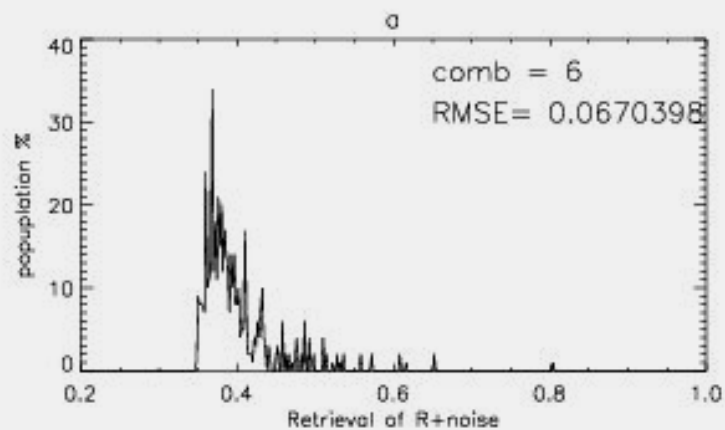
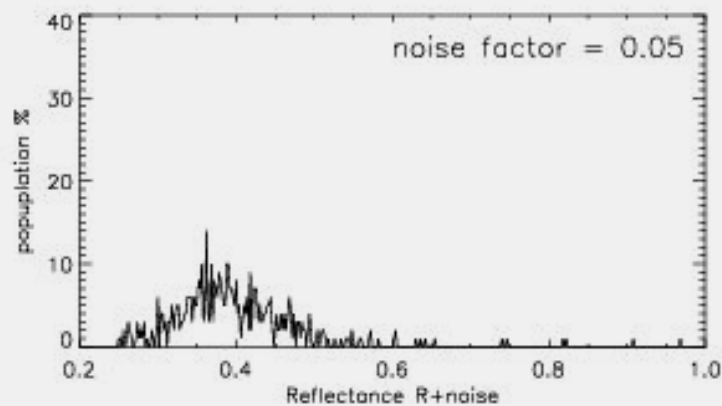
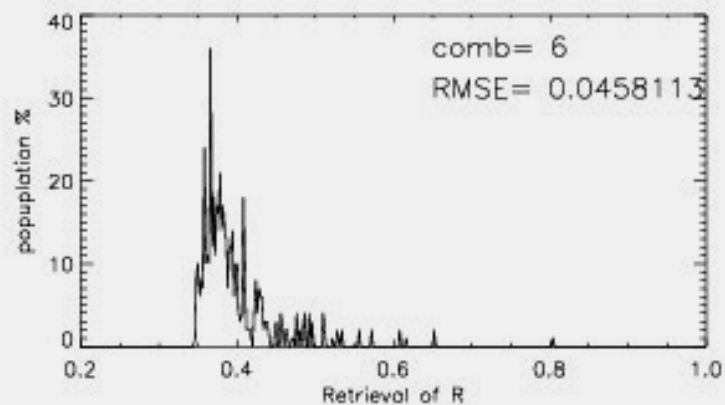
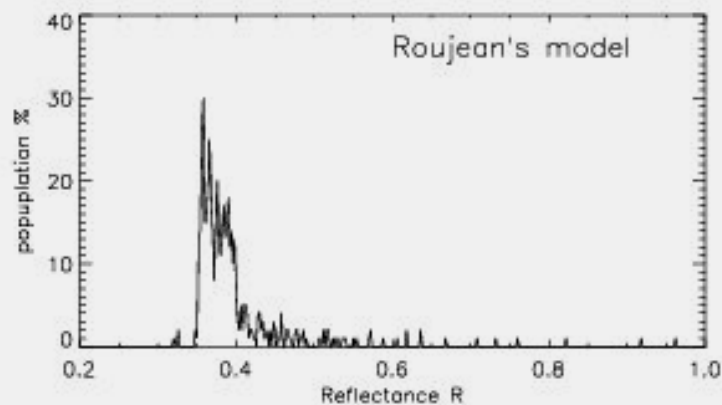
Data sources: FIFE and BOREAS experiment

Data set	Surface Type	Date	values
ssa-9oa	Aspen Tree	07/21/94	546
ssa-ojp	old jack pine	07/14/94	540
ssa-obs	old black spruce	06/07/94	432
72272655	grassland	08/15/87	546
92162133	grassland	08/04/89	312



SENSITIVITY ANALYSIS

Comb #	RMSE vs Height/Shape					
1	1.0/1.0	1.0/2.5	1.0/4.0	2.0/1.0	2.0/2.5	2.0/4.0
2	0.0141	0.0143	0.0145	0.0138	0.0143	0.0145
3	0.0187	0.0199	0.0203	0.0187	0.0202	0.0206
4	0.0144	0.0184	0.0199	0.0143	0.0188	0.0201
5	0.0193	0.0221	0.0230	0.0192	0.0226	0.0232
6	0.0162	0.0173	0.018	0.0166	0.0180	0.0187
7	0.0199	0.0204	0.0210	0.0206	0.0213	0.0218
8	0.0123	0.0135	0.0140 ...	0.0132	0.0147	0.0149 ...
9	0.0146	0.0150		0.0157	0.0164	
10	0.0167	0.0173	0.018	0.0167	0.0180	0.0187
11	0.0210	0.0204	0.0210	0.0207	0.0213	0.0218
12	0.0248	0.0256	0.0258	0.0248	0.0256	0.0258
	0.0313	0.0320	0.0322	0.0313	0.0320	0.0322



Summary

- The kernel model combination provides better BRDF retrieval .
- RMSE criterion is used, but other criteria should be flagged for quality notification.
- Algorithm is reliable and promising.

Acknowledgements

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